Models of the Universe from Hipparchos to Hawking

Spring 2003 Graham School Master of Liberal Arts

Rocky Kolb

Lectures: Saturdays 9:30am - 12:30pm, Gleacher Center

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Grades will be based on a final paper. The paper will be in the form of a research proposal for the investigation of some specific research program. Details will be provided later in the term.

There are four ***Textbooks***:

- *Blind Watchers of the Sky,* Kolb
- *The Little Book of the Big Bang,* Hogan
- *The Inflationary Universe,* Guth
- *A Brief History of Time,* Hawking

The class ***website*** is http://home.fnal.gov/~rocky/Graham03/. All images shown in class will be available on the website.

Course Description:

The course will involve lectures and discussions addressing the question "What do we know about the universe and how do we know it?" We will discuss the creation of spacetime and the universe and how it evolved to produce chemical elements, galaxies, and stars, and thus provide the basis for other evolutionary processes. We will discuss what is meant by, "the universe," as well as gain an overall perspective of things such as planets, stars, black holes, galaxies, quasars, and spacetime, as well as matter, energy, and fundamental forces. We will discuss the expansion of the universe. In order to understand why we believe the universe is expanding we will learn about the structure of atoms and the nature of light. (It is intriguing how the smallest things in the universe determine the structure and evolution of the largest things in the universe.) Also, we will look into the question of how matter is distributed in the universe, what it looks like, and how dense it is. This will lead to a discussion of gravity, both the Newtonian theory of gravity and Einstein's theory of General Relativity. We will find that space itself in the universe may be curved. Then, in order to learn more about the nature of the universe, we will study the properties of radiation from hot objects. We will learn that the universe is radiant, but at a temperature of -454 F. This information will support the idea that the universe emerged from a hot, dense state. We will study the birth of

the universe and show how the earliest moments were dominated by high-energy physics phenomena. We will see how forces and particles behaved at this early time, and how their behavior resulted in structures that might eventually evolve into galaxies and stars.

The universe is more interesting than the people who study it. However, the study of the universe is a human endeavor, and the story of the people and ideas that shaped our view of the universe is a great story. The early part of the course will provide an historical background that will better enable us to appreciate the ideas of 20th century cosmology and the issues facing cosmology in the 21st century.